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an agency perspective on water, values and infrastructure**

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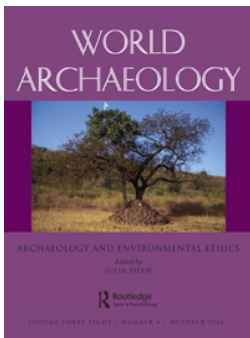
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‘Friendship is a slow ripening fruit’: an agency perspective on water, values and infrastructure

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ABSTRACT

This paper argues that human and material agents co-shape ‘morality’. Water systems will be discussed in more detail. Artefacts (technologies) relate humans and their worlds, but the specifics of this relationship become meaningful only within specific actor-networks. As such, the material influences the moral decisions of humans. Examples from the larger Mesopotamian area, on both state-led and community-managed water systems, are discussed to show that these result from activities of individuals, households and groups manipulating water fluxes in short time periods of hours and days. Analysis of these daily activities, and especially of how the material acts, offers options for archaeologists to trace morality in action.

KEYWORDS

Irrigation; Mesopotamia; modelling; morality; artefacts

The quote in the title, assigned to Aristotle, reads in full: ‘Wishing to be friends is quick work, but friendship is a slow ripening fruit.’

Introduction

Sometime, in southern Mesopotamian many years ago – possibly as many as 7,000 years, before the Ubaid period – there may have been a farmer who could not find the land she wanted to use to grow crops. Given that all that was needed was ‘a short cut in the river banks’ (Buringh 1960, 255) to create new irrigated land, she moved to another location and planted her crops. Soon enough, others joined her, after providing assurances that what they did was allowed by those community members with established fields. After all, disturbing those who had farmed for a long time was neither desirable nor fair. Several thousand years later, a ‘dismayed provincial official who could not see how he should be able to provide the state with the assigned quota of 1000 homers of corn and still maintain his office’ wrote a letter to Sargon II, king of Assyria between 721 and 705 BC, to complain that he could not easily produce the crops he was supposed to compared to his colleagues from other provinces nearby (Radner 2000, 243). Simply put, the official argued that being asked to come up with 1,000 homers was not fair.

If there is a single resource that has invited scholars to study human well-being and suffering in relation to their environment, it might be water. Water systems in their many shapes and sizes,

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human relations with rivers and lakes and cultural manifestations of water within societies have been subject of study, in, among others, *World Archaeology* itself as in the special issue on water (2009.1). Within archaeology, water systems supporting food production for larger populations have been particularly well studied for regions as different as Mesopotamia, the Nile and its delta in Egypt, ancient India, the Yangtze and Yellow Rivers in China, Central Mexico and the coasts, mountains and rainforests of Peru. The close (perceived) relation between (urban) elites and water control has led to water becoming a topic under rather overarching models such as the 'archaeology of power', of which Wittfogel's model of hydraulic civilizations remains without doubt the most famous attempt to study water and society in ancient times (Wittfogel 1957). Without suggesting that Wittfogel provided a convincing analysis (see below), linking water and power still makes sense. As I argued in a recent paper on colonial Sudan, power relations are typically channelled through infrastructural media and material agents such as canals, roads and gold (Ertsen 2016a, 2016b).

In this paper I will argue that engagements between human and material agents are key to understanding how 'morality' is shaped and transformed. My general argument builds most directly on actor-network approaches (especially Latour 2013, 2000; see also Strum and Latour 1987). Actor-network theory is not the only one available on the relation between human and non-human agents. I find additional theoretical inspiration in the concept of entanglement between humans and things as developed by Hodder (2012, 2014; see also Strang 2014), even though, as discussed towards the end of this paper, I consider the concepts of actor-networks better suited for the argument I develop here. In particular, I will suggest that artefacts (technologies) 'play an active role in the relationship between humans and their world': artefacts 'have "intentions", they are not neutral instruments' (Verbeek 2006, 365; cf. the notion of the extended mind in Clark and Chalmers 1998). However, these intentions matter only within actor-networks, when meanings are acted out through engagements between human and non-human agents. In these emerging relations, technologies, artefacts and the material in general 'help to shape what counts as "real"' (Verbeek 2006, 366). This is an important notion, as it means that the material has a say in 'the moral decisions human beings make' (366). Ethics 'is about the question of how to act, and technologies appear to give material answers to this question' (369). What is required is careful analysis of material agencies in order to enable archaeologists to trace this morality-in-action – obviously an extremely challenging quest given the fragmentary and incomplete archaeological record.

I develop this argument about studying morality in action through material agencies below. First, I explore how water features in larger-scale studies as an object of normative judgement. This is followed by a discussion on the analysis of water systems in general, followed by a descriptive and then agency-oriented discussion of two Mesopotamian landscapes. I conclude with two paragraphs on selected methodological and theoretical concerns for future work.

Grand water narratives

As water is of fundamental importance to human beings and societies, one can understand why the genre of 'grand narratives' on how human society should use its water sources or manage water conflicts is popular. In studies like Fagan (2011), Mithen (2012) and Solomon (2010), we generally read about Mesopotamia, Petra, Rome, the Grand Canal in China, Angkor, the Maya and the Hohokam, with explanations for why these societies prospered, how they failed and why we in our own – modern – society would do the same – or not. Quite often these water stories use

historical concepts of human well-being and suffering in relation to environmental ethics and historical ecology to answer the question of how we – modern society, which is set apart as a particular social, religious or political group – should respond to new environmental challenges. One of the better-received ‘grand narratives’ argues that ‘leading civilizations have been those that transcended their natural water obstacles to unlock and leverage the often hidden benefits of the planet’s most indispensable resource’ (Solomon 2010, 14), suggesting modern society (or perhaps only the USA) should do the same in order to lead – or keep leading.

In other words, history and archaeology are mobilized to develop a political perspective. Interestingly enough, the same history appears to be able to support different perspectives: for one, the market is the solution, whereas for the other more state intervention would be beneficial. Whatever the preferred solution, I would argue that water does not have ‘hidden benefits’ of its own: water and society are mutually constituting elements and cannot be understood in isolation from each other. As such, it is rather difficult to speak of ‘natural water obstacles’, in Solomon’s (2010, 10) words. Determining the natural water balance of a region to be ‘wrong’ is misleading, as it gives an inaccurate impression of a relationship of neutrality between humans and water. Indeed, water ‘is as deeply embedded in the social fabric of modern Western culture as the tanks of southern India or the water temples of Bali are embedded in those cultures’ (Linton 2010, 181).

Water is a political matter, as much as framing water problems in neutral quantitative and qualitative terms is a political matter too. With this in mind, it is reasonable that Linton (2010) seeks to criticize the move towards defining water as an economic good, as this move is typically presented as a neutral – natural – step. Water would be one of those elements that can be traded freely. Linton does not deny that that water can be traded, as thinking otherwise would be another simplification, but argues that the simplicity of the trading argument appears to rest on a specific conceptualization of water in its social environment (Linton 2010, 227). Linton introduces the term ‘hydrolectics’, his version of dialectics, but in the end such jargon shapes a very simple and perfectly acceptable message: water is never neutral stuff. Water is power.

Wittfogel’s hydraulic hypothesis remains one of the first attempts to connect the control of water within a specific environment to state development, defining mobilization and coordination of the massive labour needed to build irrigation as a key factor in state formation (Wittfogel 1957). In his original thesis, the diversion of water from rivers to areas without reliable rainfall forms the basis of these civilizations. According to Wittfogel, water and labour control were vital in producing food surpluses supporting the non-peasant population, but his claim that large-scale irrigation development preceded state formation has been heavily criticized over the years for being too simple, too political or simply wrong (for a useful discussion, see Harrower 2009). One could label the central question in many of these critical discussions as of chicken-and-egg type: which came first, the central state or large-scale irrigation?

Whatever was first, though, the shape that this power takes and the way we would like to evaluate that do not come directly from history as such – as if history teaches us lessons or even that future directions can be detected from the past. Many are ‘trying to connect pressing current environmental issues with their past histories’ (Melosi 2011, xi). However, we should not hide the contested nature of water nor presume a simple linear trajectory as explanations for problems in our own times. One of the big current debates in water studies is whether private management of water distribution is better than public management, with many proponents of private responsibility suggesting that it is a logical choice to make for current societies. However, there is no

historical evidence for such an exclusive choice between public and private: the private and the public are intertwined, making the 'questions of control ... a great deal messier' (Melosi 2011, 199). What history can demonstrate is how notions like 'private' and 'public' were shaped in practice, how complex relations between different agents might have been and which management dilemmas were faced by the historical agents.

While the past can point us to certain directions of change, its lessons are rarely directly applicable to present concerns. Nevertheless, many of the overarching studies on the archaeology and history of water make a more or less strong political claim (like Fagan 2011; Solomon 2010; see also Linton 2010); as such, they show a problem similar to that of Wittfogel's contribution. Both Solomon (2010) and Fagan (2011) tend to treat the water systems they describe as static entities, in the sense that they were constructed as single entities. As such, both studies underplay observations that water systems may have developed over many decades or centuries and may be less uniform in shape than a single entity would suggest. Even in those systems where we might have a central state that encouraged the spread of irrigation systems by exerting power over vast areas, like the Neo-Assyrian state (Ur 2005), such a day-to-day perspective would be required to understand how these state-controlled systems were realized on the ground. As I recently argued, even for states that have shown strong abilities to control the agencies of humans and materials, realizing the power to do so is hard work, which can result, among other things, in less uniform irrigation systems in terms of construction, water use and daily management efforts (Ertsen 2016a). I argue that our understanding of the past has to be based on the way(s) certainty was created on a day-to-day basis by different agents

In contrast, studies like Linton (2010) and Solomon (2010; see also Fagan 2011) build on sweeping certainties, based on hindsight: history would have shown how things went right or wrong, what to do or not to do and what is the best way out of our current problems with water distribution and sustainable use. Comparative water history does not necessarily have to produce those certainties. Mithen's (2012) question as to whether our own water-dependency would also have been felt in the ancient world provides a much more useful comparative and general history of water systems. Despite the rather dramatic title of Mithen's 2012 book *Thirst* (a focus which does not necessarily apply to all the case studies discussed therein), he maintains his focus on the question of dependency and does not allow his own answer to that question for modern societies to guide the discussion of every archaeological case. As such, Mithen does not use archaeology to confirm a larger argument about which type of society one should prefer. Mithen and Black's (2011) earlier water-focused work on the Wadi Fyanan project in Jordan stands out as a detailed study of one region, building links – or allowing the building of links – between many aspects of water systems, including hydrology, infrastructure and power relations. I shall include some of these same aspects in my discussions below.

Moral niches

In Scarborough's (2003) comparative study on water systems, it is suggested that differences between small-scale (local) and imperial (large) systems can be related to the wetness and dryness, in terms of rainfall, of those worlds. In the dry zones imperial systems built on 'techno-tasking' would prevail, whereas in the wet zones smaller-scale 'labour-tasking' realities would emerge. Basically, the old world yielded empires based on technology, whereas the new world did not go beyond local communities based on labour (see also Scarborough and Lucero 2011). In this paper,

I will suggest that wet and dry properties of regions can be relevant when studying water systems – as expressions of materiality – but should not be too readily associated with specific modes. Wet labour and dry technology ask for the same methodological approach, as both are built on local interactions between human and non-human agents (see Dobres and Robb 2000; Gardner 2007).

Water and irrigation can bring wealth and stability to communities and nations, but can also harm landscapes and food production on the long term. A narrow environmental threshold may separate stable, irrigated landscapes from unstable, over-used ones. The archaeological record is filled with irrigation-related disasters, many of them related to climatic change (Costanza, Graumlich and Steffen 2011; McAnany and Yoffee 2010; Schwartz and Nichols 2006). Ancient Mesopotamia would have ‘collapsed’ because of salinization due to over-irrigation. However, this ‘disaster’ unfolded over centuries. Any discussion of societal collapse should incorporate time or rate of change. Many civilizations collapsed or disappeared over the course of centuries; over such long terms societies should be allowed to change without being labelled as unsustainable or as having collapsed.

Small-scale activities many thousands of years ago in mountainous regions such as the Caucasus and southern Arabia, and plains like southern Mesopotamia, increased the capacity of such regions to sustain large populations over long periods of time (Wilkinson, Rayne and Jotheri 2015; Ertsen and Wilkinson 2014). These early anthropogenic irrigated landscapes seemed to have emerged from short-term activities, but long-term effects were massive. It is very likely that the full-scale effects of interventions are visible to humans only after some time has passed, possibly only in the next generation, which would make it very difficult for these subsequent generations to relate the effects back to actions by their predecessors. The many agents active within larger imperial systems brought about changes in the environment as well. Introducing water through canals brought silt, plants and animals to formerly drier land. Development of large-scale canal systems, for example the Grand Canal in China (Mithen 2012) or the canals of the Assyrians (Ur 2005), appears to have created transport options for bulk products such as cereals. This transport of bulk products may have led to city growth, but also possibly increased pressures on the systems and those that had to ensure their continuous functioning. The regional hydrology changed. In southern Mesopotamia, disposal of excess water from irrigation canals into the marshlands would have affected fishing and the exploitation of other marshland resources. More speculatively, excess irrigation water could have enlarged the marshes’ area, creating the conditions for the spread of malaria, which in turn may have caused human genetic changes (Wilkinson, Rayne and Jotheri 2015; for another example relating water management to genetics, see Kaptijn 2015).

Like other animals, humans are active in ‘niche construction’, modifying their habitat, which can alter selection pressures on behaviour through feedback (Kendal, Tehrani and Odling-Smee 2011; Odling-Smee, Laland and Feldman 2003; Scott-Phillips et al. 2014; for the related concept of evolutionary history, see also Russell 2011). Niche construction should not be treated in environmentally deterministic ways; rather, the engagement between environment and humans creates opportunities for humans to re-engage with, to continue modifying their environment and therefore influence their future, with the environment as an ever-present agent. The examples of lactose intolerance (Gerbault et al. 2011) and sickle-cell tolerance for malaria (O’Brien and Laland 2012) are well-known examples of niche construction; another example is the domestication of ‘wolves’ into ‘dogs’ or the general transition from hunter-gatherer-based to agriculture-based societies (Rowley-Conwy and Layton 2011; Smith 2011). Concerning the latter, human agency interacting with land and water has been important in many different global contexts (see Kaptijn (2015), including the Alpine region where

artificial snow has created favourable conditions for human winter sporting activities, as well as the growth of certain algae (Gross and Winiwarter 2015).

Having discussed the ways in which small-scale and short-term agencies relate to larger-scale and longer-term changes, I will now introduce two cases of irrigation development in the larger Mesopotamian area, arguing that all ancient water systems, whether state-led or community-managed, result from the activities of individuals, households and groups manipulating water fluxes in short time periods of hours and days (Ertsen et al. 2014). I will also argue that the hard (physical) work of dealing with the environment and its associated stresses (drought, floods, diseases, etc.) shapes more than the relationships between human society and 'nature'. Through these activities, the ways in which human agents value results, systems and relationships develop as well, including (perceptions of) issues of inclusion, control, payment and dislocation. The question of whose labour is rewarded, and in what way, an issue with immediate practical and moral implications, is shaped through cooperation and struggle (see the recent volume on cooperation in *World Archaeology* (DeMarrais 2016)). In other words, I propose a study of 'morality in action' (Van de Poel and Verbeek 2006, 227).

Material morality

I propose, therefore, to focus on interactions between human and non-human agencies (see Ertsen 2016a). Studying morality in action may provide some insights into the changes and continuities that we encounter in the archaeological record, as for example discussed by Pollock (1999) and Ur (2010) for southern and northern Mesopotamia respectively. Both authors explore in detail the complex histories of their respective regions, but for both it remains difficult to separate description and explanation. This is illustrated in their treatment of emerging power relations of production in the south in the third millennium. Apparently, an overarching institution like the 'oikos' (collective economy of a palace, estate or temple, in which almost all that is consumed is produced as well), 'incorporated its own large and varied workforce', (posed as description) because it could increasingly control the means of production (posed as explanation) (Pollock 1999, 120). I would argue that in this case, as in many cases in archaeology, description and explanation are different phrasings of the same observation. Obviously, social institutions, hierarchies, do exist; I argue, however, that such structures are not the explanatory forces we want them to be, as they need to be re-enacted continuously. In this re-enacting, the material is a key agent. Human agents produce "'ethics by other means": they materialize morality' (Van de Poel and Verbeek 2006, 227; Verbeek 2006, 369).

Studying morality in action through actor-networks would also open up options to leave one's own perceptions of what is correct or wrong – or fair or unfair for that matter – as much as possible out of the analysis, even though that is not always easy. A claim that imperial landscapes in Assyria were 'expressions of (male) sexual anxieties and ideologies' (Marcus 1995, discussed in Radner 2000) may be more easily perceived as based on personal preconceptions. There is no need to doubt that relations between men and women are important in understanding Assyria, including how claims and ideologies were mobilized, but that would not suggest that we should use terms with such clear ethical and moral claims attached to them, especially when the evidence is rather scarce (Radner 2000). However, even for terms that may sound rather neutral – innocent even, especially when they have become part of the disciplinary vocabulary – we may need to be careful as well. A term like 'tribute' may not simply imply a transfer of stuff that represents a certain value, but also presuppose a social relation with predefined power positions for those that pay and those that receive.

As such, 'tribute' is a moral term, just as words like 'temple', 'public' or 'complexity' are as much moral terms as they are scholarly concepts. Whether a space with certain dimensions is labelled as

a 'temple' or as a 'fortress' depends on the perception of the observer and his/her relation with the space. Using the term 'public' presupposes a difference between public and private, but also suggests that those people who would find themselves in the larger space at a moment in time would consider themselves to be in a non-private space. In other words, the concepts we apply to the material record that we encounter, predefine to a certain extent the actions and perceptions of the ancient actors we study.

Obviously, there is no escape from our own social, cultural and religious concepts and dimensions – nor from our language – when we study and write about how environmental challenges have impacted on human well-being, health, economic stability and coping strategies elsewhere and in other times. Our own concerns certainly guide the questions we want to answer with our archaeological records, in our aim to discover more about management of natural resources, strategies for dealing with environmental stress and relationships between society and nature. Nevertheless, I would argue that we can make certain methodological choices in how we approach our topic and how we construct our argument. Even though the outcomes of combined agencies are often idiosyncratic and unpredictable, I argue that they can be studied systematically as we are relatively certain that those interactions create outcomes within material boundaries (Ertsen 2010).

An actor-network approach may also be relevant to another problem of archaeological studies. Power relations are usually associated with the concept of social complexity, which is typically 'described through the nature of interactions between individuals and groups' (Ur 2010, 388). The underlying assumption is usually that societies grow in complexity over time, although Ur (2010) suggests northern Mesopotamian societies have shown periods of greater and lesser complexity over time. That in itself may already be a problem, as these quasi-quantitative terms suggest that complexity is measurable, but in this paper I would like to focus on another issue. The discipline of archaeology is especially interested in 'material manifestations' (389) of complexity. Straightforward as this may sound, the term 'manifestations' poses a problem, as it suggests that something like power – or any other social relation – can exist without a material shape. As I have argued (Ertsen 2016a), power is not a force or entity out there on its own to be manifested in matter: power and matter go hand-in-hand, power is realized through the material. A road is a power relation, and so is a canal or a text. The same argument can be made for an entity like the 'state' or other larger social entities: these need material engagements to exist (see Schouten 2013).

A tale of two Mesopotamias I

Recognizing a single point of origin from which comparable human engagement with the southern Mesopotamian landscape would have started is unlikely. Without becoming environmentally deterministic, it can be said that south Mesopotamia does have plenty to offer in terms of rich soils (of different types), water from rivers and levees (although sometimes too much) and the many resources in the marshlands. The earliest water systems may have taken advantage of seasonal flood water to plant crops on patches of land that dried after a flood (Wilkinson, Rayne and Jotheri 2015). Did such systems lead to positive returns, in terms of growth of irrigation systems and communities, or was the system too opportunistic to allow that? How did farming communities manage to scale up smaller systems? As we know that this scaling up occurred, we have to assume that early efforts resulted in positive returns in terms of food and energy production (Wilkinson, Rayne and Jotheri 2015; Jotheri, Allen and Wilkinson 2016; Ertsen and Wilkinson 2014).

Given that the landscapes of southern Mesopotamia appear to us as 'hydraulic landscapes, because water is the specific structuring agent in what is actually a complex array of rivers, canals, distributaries and marshes which dominate and in part create the landscape' (Wilkinson, Rayne and Jotheri 2015), something more than opportunism seems to have played a role. Exactly what happened in terms of landscape creation is still a topic of research, but it seems safe to argue that the waterways of Mesopotamia are a mixture of natural and human-produced channels. Both water courses flowed higher than the landscape on levees, but exactly which one was natural and which not remains to be studied (see Jotheri, Allen and Wilkinson 2016). However, we would expect patterns like the Khuzestan levee irrigation areas in ancient Iran, in which short canals flow down slope of longer levees to irrigate fields (Wilkinson et al. 2012; see Heyvaert and Baeteman 2008; Heyvaert et al. 2012).

As far as we understand now, these gradually developing water systems were fundamental to the development of Mesopotamian society in the fourth and third millennium BC (Wilkinson, Rayne and Jotheri 2015; Ertsen and Wilkinson 2014). Imagine a flat landscape with water channels on very low gradient with higher-level levees moving through it. With levees being wide (possibly up to a few kilometres), agriculture would have been possible on the levee side slopes. Obviously, watering fields would have been an issue – according to the available climate data, rainfall in southern Mesopotamia during the period in question was below 200mm on average, about the same as today (Wilkinson, Rayne and Jotheri 2015). Productive water systems could have developed from a system of crevasse splays, where each new breakthrough of a levee created a mini alluvial fan (Wilkinson, Rayne and Jotheri 2015; Ertsen and Wilkinson 2014). These fans could be used as flood recession systems, potentially being enhanced over time with some canal features along the slope, but interestingly enough one could also create a new breach elsewhere along the levee – as the farmer in the example in the introduction did. Palm gardens would have been developed close to the top of the levee, with cereal crops being grown further down slope. Once in the lower flood basin itself, salinization would limit agricultural activities (Altaweel 2013; see Wilkinson, Gibson and Widell 2013). Might these adaptations and uses have formalized into a series of irrigation systems along levees? Did canals indeed start by budding off from crevasse splays? Did other groups or sections of growing communities start new systems? If so, any new community might operate not immediately next door but probably some distance downstream to start another system that would be formalized into canals. As such, complex systems could start off very simply. Does this mean that the resulting hydraulic landscape was shaped through a growing number of smaller-scale systems administered by kin groups over 5,000 years and thus locally managed through time?

Many centuries later, during the period of the later territorial empires in the first millenniums BC and AD (Neo-Assyrian to Abbasid), the area of northern Mesopotamia saw irrigation, agriculture and settlement expanding into marginal areas of previously low crop production in a much shorter time period of centuries, perhaps even decades. Much of northern Mesopotamia can be regarded as marginal because it lies within a zone of uncertainty for rain-fed agriculture. While the modern area receives between 200 and 400mm of rainfall per annum, this is also very variable from year to year; a similar situation can be assumed for the Assyrian period (Ur 2010). The link between water systems and rainfall here can be seen as an example of environmental opportunism; one could take advantage of the available precipitation but, where necessary, would increase yields by constructing irrigation systems to intensify yields. Given the topographical features of the landscape, however, constructing irrigation systems from the larger rivers with their water levels below the fertile valleys was not as straightforward for smaller communities as it would have been in southern Mesopotamia with its levees above the fields (Wilkinson, Rayne and Jotheri 2015).

It is along the Tigris River that we find an example of a state doing exactly what local communities could not do: creating irrigation systems. The Assyrian empire emerged in the early first millennium BC, with an imperial core around modern Mosul. From the city state of Ashur, Assyria expanded to regain the territories lost by the Middle Assyrian state at the end of the second millennium BC. Later, small kingdoms were included in the Assyrian core as provinces or closely controlled client states, in areas of modern Iraq, western Iran, south-eastern Turkey, Syria, Lebanon, Jordan and Israel. The imperial core, including its cities, appears to have been carefully planned (Wilkinson et al. 2005; Ur et al. 2013; Ur 2010). The kings also commissioned large canals and dams, which redirected natural surface water flows from the hinterlands towards the capital cities. Canals feeding Nimrud and Nineveh have been found, but were not limited to the imperial core (Ur 2005). Often, these water systems are seen as providing water for elite parks and gardens, not to productive areas. However, a reassessment based on satellite imagery (Ur 2005) suggests that cuts existed along the canal banks, which suggests local water use, possibly irrigation, at a distance from the capitals. As the rural countryside of the Assyrian core is almost entirely unstudied, the exact uses and functions of these water systems remain unknown.

Some evidence for the rural area, however, can be found in areas like eastern Syria, with its pattern of evenly spaced small villages (Wilkinson et al. 2005; Ur 2010). Neo-Assyrian settlements seem to be dispersed, possibly placed deliberately in open spaces left by earlier settlements (Wilkinson et al. 2005). As neo-Assyrian kings had a policy of deporting the populations of conquered regions, resettling them elsewhere in the empire and replacing them with other conquered populations – partially punitively – such a model holds well. Through forced settlement, labour was made available in the core area, especially the newly founded capitals. The dispersed settlement pattern on the fringes of the imperial core may be the other aim of the same policy, as the new population would allow agricultural intensification

A tale of two Mesopotamias II

Typically, although we encountered, in terms of archaeology, large-scale irrigated landscapes in southern and northern Mesopotamia, we also appear to encounter two rather different models in terms of cooperation, conflict, power and as such ethics and morality. Following DeMarrais (2016), we could perhaps distinguish between consensus and coalition, where only the coalitions leave material traces that can be studied by archaeology. That distinction would not hold, however, as the more 'loosely' consensus-based cooperative landscapes of the south did leave material traces. Following Scarborough's (2003) model of dry versus wet zones and their associated realizations of labour and power relations, we should perhaps see the south as a labour-tasking case, whereas the north was a techno-tasking one. I am not convinced that such a distinction holds well either. Neither northern nor southern systems/landscapes were constructed in one go. It may be the case that the Assyrian systems were constructed over decades, whereas the earlier southern systems may have taken centuries, but issues of labour and resource control for both communal and state-led initiatives need to be understood within a longer timeframe. Often, this also means that larger-scale systems are less homogeneous than sometimes assumed: early parts may look different than later parts. Paraphrasing Latour (1993), as much as we have never been modern – suggesting that 'traditional' and 'modern' societies should be understood in similar terms – we have never been imperial, suggesting that 'local' and 'imperial' need to be understood on an equal footing as well (for an overview of different empires, see Morris and Scheidel 2010).

Let us consider our two Mesopotamian cases once more in terms of continuity, change and power. The crevasse system of the south would not be immune from elite (state) influence and control. These locally controlled productive areas could have been a base for surplus production; a central state could have come in and, for example, extracted taxes from the systems. However, given my earlier remarks, we should not allow an entity to 'come in', but rather explain how such an entity could have developed. Recent scholarship on Mesopotamia (Rost 2015; Rost and Hamdani 2011) – based on the extensive collection of clay tablets describing maintenance activities and on hydraulic analysis – may open up the possibility that urban elites managed to secure agricultural produce by controlling trade, without interfering in the agricultural production as such.

Rost (2015) shows, for Umma province, that water channels were managed for the combined functions of irrigation, navigation and flood control. Obviously, bringing water to fields was crucial for producing agricultural surplus, but water transport was the key to bringing the surplus to the urban centres. Preventing the peak flood to disturb harvesting, flood control was as important as irrigation. The elements of the water system around Mesopotamia played a vital role as trade routes transporting bulk products, but not necessarily as controlled systems managing food production. Once water levels are the key target for canal management to allow shipping, water availability for irrigation from the same channels is no longer an issue. The urban and the rural in Mesopotamia were indeed closely connected, but the perception that the urban elite had encompassing control over its rural environment may need revision (see Rost 2015; Wilkinson, Rayne and Jotheri 2015). Urban elites may have developed because they were able to use connections between different communities through the network of waterways in Mesopotamia. Rather than the control of productive activities, the ability to trade (or perhaps exploit) other people's harvests was the key. This may have led to the start of arrangements like the *oikos* institutions (see Pollock 1999) and as such a redefinition of power relations. We may have uncovered a key process of morality in the making.

In general, in future work, I would be interested to study the co-evolutionary transformation of practices and arrangements in southern Mesopotamia. The effects of different farmers' strategies could be explored. Optimization strategies on a regional level, in terms of maximum profit, would require the many irrigation systems to act as one entity. However, local communities might be less inclined to adapt their short-term actions to ensure 'total system benefit', not necessarily for any predefined objection against shared benefits, but simply because it would not be easy for local actors to arrange short-term actions in line with longer-term shared outcomes. We could include agents that are more interested in trade as well. Whatever sets of actions and cases we study, the outcomes of water development processes are known: somehow many systems in southern Mesopotamia managed to function over longer periods. Their properties evidently did change, but continuity is a common feature in the archaeological record. This would usually mean that a kind of conflict resolution must have been in place, most likely through mechanisms generally found in common pool resources (Ostrom 2012). Obviously, within the larger irrigated landscape, some communities and their water systems may have disappeared; we should carefully study conditions for longer-term success or failure of specific systems and situations. Different cooperation strategies, including (in)direct tit-for-tat and the slightly more advanced generous tit-for-tat (when first defection is still followed by cooperation) can be explored. Such explorative work, including agent-based modelling (see the final paragraph of this paper) would allow us to determine the conditions under which specific strategies might be more successful (see Carballo, Roscoe and Feinman 2014; Nelson et al. 2010).

A similar strategy of analysis would be preferable for our northern Mesopotamian empire. The landscape of the Assyrian imperial core suggests intensive planning in all aspects and features one

would associate with a despotic state (Ur et al. 2013; see also Adams 1981; Altaweel 2008). The larger cities were densely populated centres of political, religious and economic power; the colonized countryside provided food for the cities via forced immigration. Food production was enhanced through huge interventions in the natural hydrology, with dams, tunnels and canals (which served as handy symbols of royal legitimacy too). As I show in my recent book on a British colonial irrigation system in Sudan, however, for imperial situations we still need to consider that continuous negotiations shaped the scheme's canals, crops and farmers' resistance, as well as the contested symbol of development itself (Ertsen 2016b). My interpretation of such top-down projects suggests that a centrally planned colonial effort, as in the case of the Assyrian canal systems also, was continuously in the making and as such unfinished (compare with Darwin 2012). Empire is shaped by strings of daily actions similar to those mentioned above, only this time in offices and fields, in political debates, and in symbols; it is mobilized through buildings, gold and canals.

Even if the archaeological record suggests a successful outcome, in terms of imperial infrastructures, production of power spaces is not a process that simply produces social structure from a pre-defined plan. Rost (2015) allows for a much closer understanding of the agency of empire or at least elite control over (southern) Mesopotamian water systems. For northern Mesopotamia, we read about a neo-Assyrian road station in Syria that 'lacks people' and needs people to be settled and given 'fields and gardens' (Radner 2000, 238). We read about plagues, floods and storms as well. Power, space and empire are produced and reproduced through cooperation, struggle, conflict and contradiction between the human and the non-human – between agents of different kinds. As I have shown for colonial Sudan, Sudanese tenants did strive for their own benefits and succeeded to a degree. Colonial control was partly dependent on such benefits being allowed to be there (Ertsen 2016b). Fales (2009–10) and Galil (2007) discuss whether forced re-settlement in neo-Assyria could be executed without possible benefits for those settlers.

Matters of ethics

Within archaeology, it is good to note that 'the fragility of political centralization and the ability of uncoordinated actions by individuals to create and structures and effect change' are receiving more and more attention (Ur 2010, 412). Attention to 'fragility' is acknowledging that creating lasting institutions relating to the landscape 'through the redistribution of agency over networks composed of human and non-human "actors"' (Schouten 2013, 9) is hard work for all human agents (Hodder 2014, 21), precisely because the landscape and its non-human colleagues strike back. Through their agency, human agents are continuously (re)shaping their relevant network, linking themselves with other (non-human and human) agents within the landscape. As DeMarrais (2016) in a *World Archaeology* special issue on the archaeology of coalition and consensus, shows, infrastructure is 'a materialization of ongoing communication, in which there are often conflicts among different constituents to achieve consensus' (Smith 2016, 164). Social relations need the material, but those relations cannot simply 'be stored in a bank': it is through the material that those relations need continuous confirmation, reconstruction and adaptation (Latour 1991, 118; see also Hodder 2012, 2014; Hoestaker 2005).

Continuous confirmation is exactly what matters for the 'material underpinnings of rule' (Schouten 2013, 21). Both our Mesopotamian snapshots show examples of the production of infrastructure (in the shape of either modified nature or man-made features). In both case-study areas the resulting infrastructure is (partially) an expression of human agency and as such closely related to norms and

values. In a 'progressive construction of reality' (Latour 1991, 117), morality is produced along the way, simultaneously, in terms of values and material ways, allowing those values to be acted out. Who has access to water or crops? Who is re-settled or not? Should a poor province provide less tax? Who opens the gates? It is not necessarily the case that judgements of 'good' and 'bad' are deliberately built in all the time; not every action in creating water systems is explicitly based on those judgements. However, the success with which agents build new networks 'determines the success of their designs' (Van de Poel and Verbeek 2006, 228). Working solutions become good solutions.

How these working solutions are produced needs careful analysis. Ubaid culture may have been based on the peaceful 'spread of an ideological system' (Stein and Oezbal 2007, 342; see also Ur 2010, 393), but one should question how that happened. In the same paper, we read that 'Ubaid elements actively became part of existing and well established repertoires of cultures and meaning' and that 'various aspects of southern elements are selectively adopted at different rates' (Stein and Oezbal 2007, 338). Indeed, we read about active agents engaging with the material elements that represent certain values. Even when preferences, beliefs and motives are 'explicitly formulated during a course of action, they cannot be understood as antecedents', as if there would be a clear 'beginning of a course of deliberate agency' (Waelbers and Dorstewitz 2014; 35). In other words, those norms and values are not present before being engaged, they are not floating around to be captured. There was no Ubaid culture that moved to other places. The ideological system did not spread around; the continuous interactions between agents did produce what we now encounter in the archaeological record as a spread of a culture.

Another important element of archaeological analysis is time. Within archaeology, the short term is usually on a scale of centuries, or sometimes decades. On such time scales, one might be able to suggest that 'reurbanization during the later third millennium was sudden' as it happened 'over the course of two centuries at most' (Ur 2010, 414). However, if a time scale of two centuries is the time scale of 'sudden', the industrial revolution in the eighteenth and nineteenth century was sudden as well. I doubt, though, that anyone would conceptualize that development as 'a sign of an imposed or planned aspect' (415). Time and matter are closely linked, as it is matter that shapes the world that agents move into. No-one encounters a clean sheet when coming into the/a world. Instead of anything ideological, it is the material that represents the relations that 'predate our arrival', including 'the advantages or disadvantages they imply' (Cudworth and Hobden 2013, 440). Canals, roads and seals – material stuff, infrastructures, objects – are (carriers of) social structures (Ertsen 2016a; see Strum and Latour 1987).

Producing social structures is an ethical project, as it is 'connected to moral norms and values and can be evaluated in terms of morally good and bad' (Van de Poel and Van Gorp 2006, 334). Some have more to control than others or manage to extract larger margins from activities than others. This evaluation of what is accepted (good) or not (bad) is continuously made, both by those who produce these practices and by those who study the ancient producers. When we study how morality was shaped in ancient Mesopotamia, we have to realize that designs or material realizations are options for human agents to 'delegate' certain human desires to artefacts (Verbeek 2006). Realizing infrastructures brings in future users as well (Latour 1996). In designs, water's materiality is typically mobilized (consciously but unconsciously as well) with three meanings: water as in infrastructure (canals, breaches), water as a substance with physical-chemical properties (flow, infiltration) and water as a medium for other non-human agents (salt, sediment). Artefacts are carriers of responsibilities, for example to bring certain amounts of water from A to B, although the material is not necessarily faithful to human desire (Latour 1996). Matter is 'naturally recalcitrant' (Latour 2000, 116): water may decide to flow elsewhere, as it did many times in ancient Mesopotamia.

Modelling ethics

The combination of material, cultural and religious uses and meanings of land and water has shaped water systems and has emphasized the intrinsic proximity of the natural and human worlds. Whatever their shape and size, landscapes are social practices: routinized sets of behaviours consisting of elements that are interconnected, including physical activities, mental activities, artefacts and their use, background knowledge, know-how and states of emotion (Winiwarter, Schmid and Dressel 2013). Practices typically include material objects whose existence and form are shaped through human agencies, but who also shape human agencies. Focusing on human agency shaping water-related infrastructure and institutional arrangements, such processes can be analysed as strings of ‘action→result→judgement/perception→(re)action’ within agent-based models (Barton 2014; Murphy 2012; Wilkinson, Gibson and Widell 2013). In such analysis, agents would be offered a spectrum of possible actions. From these possibilities, an agent is allowed to select certain actions based on his/her current perception of the societal and landscape context. It is the perception of the actions and their (perceived or real) results that is the variable part in the analysis. Actions and their results may be not fully predictable, but we know their boundaries are defined in principle – after all, actions should have a physical base. This approach is based on my earlier work on irrigation (Ertsen 2010, 2012, Ertsen et al. 2014), but we obviously do not have to restrict ourselves to water systems.

For some authors, the type of analysis I propose is basically unfit for any ethical consideration. Actor-network analysis has been accused of being amoral (Winner 1993), or even supporting a wrong moral (Whittle and Spicer 2008). Latour, as one of the major proponents of actor-networks, would only provide options for descriptive accounts of agency and not allow for ethics in behaviour (Waelbers and Dorstewitz 2014); a similar argument is made for power in actor-networks (see Ertsen 2016a). In his most recent work on so-called modes of existence, Latour (2013) actually acknowledges that there is more to say about ways of seeing reality – and as such on how to value realities – than just plain actor-networks. Certain ‘modes’, like politics, religion and science, would have their own ways and sets of values. Without claiming that these pre-defined distinctions are not relevant, I would still like to maintain that detailed analysis of how actors from/within different modes engage with other actors in producing realities is required. Such analysis of the actor-network would still have to reveal how specific realities become more equal than others; as such, actor-network analysis can still provide the material for ethical judgement (see Williams-Jones and Graham 2003).

I have only touched upon the Mesopotamian world, but hopefully I have shown that the assemblage of the water systems in Mesopotamia can be conceptualized as a process of human agents trying to include the ‘correct behaviour’ (agency) of the non-human actors to facilitate uses that those human agents wanted to achieve, with non-human actors often refusing to be caught exactly in the way that human actors had in mind. Landscapes are not passive or static backgrounds to human agency, as the material engages directly with other agents in producing practices and therefore in producing morality. Rivers relate actors upstream to those downstream – whether the agents are human (farmers or bathers) or non-human (fish or sediment). The same river connects agents from past and present, with possible pasts from the last few days or the last few centuries.

The Mesopotamian – political, physical, moral – landscapes emerging from archaeological data are the result of a process of “‘thinging” entities together’ (Latour 2007, 140), once by Mesopotamians themselves, the second time by archaeologists. In this ‘thinging together’, it is clear that things (matter, non-human agents) play an active role, but how should we understand that role? In Hodder’s concept of entanglement, the ‘limited unfixed nature of things in themselves and their relationships with each other’ is stressed (Hodder 2014, 24). Hodder’s

entanglement concept is a direct response to actor-network theory (specifically Latour). For Hodder, Latour pays ‘insufficient attention to the ways in which humans and things in their physical connectedness entrap each other’ (24). Hodder maintains the theoretical position that things exist on their own, with their ‘material possibilities’ creating ‘potentials and constraints’ (25). A similar position is defended by Strang, who suggests that ‘material things and their agentive effects’ constitute ‘a form of potentiality’ that is to be ‘harnessed’ (Strang 2014, 142) by human agents.

Following Latour (2013, 98), who criticizes the idea that one can extract oneself from ‘matter’ by projecting the material, ‘external world’ outside of oneself, I would not defend any position that suggests that we can study material entities independently of what human agents do or think. The claim that matter exists outside of knowing human subjects may be reasonable, but is also meaningless, as in our analysis we can deal only with representations of any external reality developed by these subjects (see Latour 1999, 2002). ‘Potentialities’ of objects are as negotiated as their ‘impacts’. Negotiating the meaning of matter/nature, for example in Mesopotamia, therefore has at least two dimensions: 1) how negotiations between humans and non-humans co-shaped morality in ancient practice and 2) how we in the present chose to study (ancient) practice, including how we conceptualize the material. If we want to ensure that our reconstructions offer the same ‘possibility of holding society together as a durable whole’ (Latour 1991, 103) as the constructions did for the ancient Mesopotamians, we should clarify how the actor-network of morality in the making was shaped by human and non-human agents alike. Morality needs to produce its own support (cf. Latour 1991).

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References

- Adams, R. M. 1981. *Heartland of Cities*. Chicago: University of Chicago Press.
- Altaweel, M. 2013. “Simulating the Effects of Salinization on Irrigation Agriculture in Southern Mesopotamia.” In *Models of Mesopotamian Landscapes: How Small-scale Processes Contributed to the Growth of Early Civilizations*, edited by T. J. Wilkinson, M. Gibson, and M. Widell, 219–238. Oxford: Archaeopress.
- Altaweel, M. 2008. “The Imperial Landscape of Ashur: Settlement and Land Use in the Assyrian Heartland.” In *Heidelberger Studien zum Alten Orient 11*. Heidelberg: Heidelberger Orientverlag.
- Barton, C. M. 2014. “Complexity, Social Complexity, and Modeling.” *Journal of Archaeological Method and Theory* 21 (2): 306–324. doi:10.1007/s10816-013-9187-2.
- Buringh, P. 1960. *Soils and Soil Conditions in Iraq. Republic of Iraq*. Baghdad: Ministry of Agriculture.
- Carballo, D. M., P. Roscoe, and G. M. Feinman. 2014. “Cooperation and Collective Action in the Cultural Evolution of Complex Societies.” *Journal of Archaeological Method and Theory* 21 (1): 98–133. doi:10.1007/s10816-012-9147-2.
- Clark, A., and D. Chalmers. 1998. “The Extended Mind.” *Analysis* 58 (1): 7–19. doi:10.1093/analysis/58.1.7.

- Costanza, R., L. J. Graumlich, and W. Steffen, eds. 2011. *Sustainability or Collapse? An Integrated History and Future of People on Earth*. Cambridge, MA: MIT Press.
- Cudworth, E., and S. Hobden. 2013. "Of Parts and Wholes: International Relations beyond the Human." *Millennium - Journal of International Studies* 41 (3): 430–450. doi:10.1177/0305829813485875.
- Darwin, J. 2012. *Unfinished Empire: The Global Expansion of Britain*. London: Allen Lane/Penguin.
- DeMarrais, E. 2016. "Making Pacts and Cooperative Acts: The Archaeology of Coalition and Consensus." *World Archaeology* 48 (1): 1–13. doi:10.1080/00438243.2016.1140591.
- Dobres, M.-A., and J. Robb, eds. 2000. *Agency in Archaeology*. London: Routledge.
- Ertsen, M. W. 2010. "Structuring Properties of Irrigation Systems. Understanding Relations between Humans and Hydraulics through Modeling." *Water History* 2 (2): 165–183. doi:10.1007/s12685-010-0023-2.
- Ertsen, M. W. 2012. "Modelling Human Agency in Ancient Irrigation." In *Variabilités environnementales, mutations sociales : natures, intensités, échelles et temporalités des changements*, edited by F. Bertoncello and F. Braemer, 199–209. Antibes: Éd. APDCA.
- Ertsen, M. W., J. T. Murphy, L. E. Purdue, and T. Zhu. 2014. "A Journey of a Thousand Miles Begins with One Small Step." *Hydrology and Earth System Sciences* 18 (4): 1369–1382. doi:10.5194/hess-18-1369-2014.
- Ertsen, M. W., and T. J. Wilkinson, 2014. "Understanding Long-Term Trends in Ancient Water Systems." In *Proceedings of the 9th International Congress on the Archaeology of the Ancient Near East*. Basel, Switzerland: Harrassowitz Verlag.
- Ertsen, M. W. 2016a. "A Matter of Relationships: Actor-Networks of Colonial Rule in the Gezira Irrigation System, Sudan." *Water Alternatives* 9 (2): 203–221.
- Ertsen, M. W. 2016b. *Improvising Planned Development on the Gezira Plain, Sudan, 1900–1980*. New York: Palgrave MacMillan.
- Fagan, B. 2011. *Elixir: A History of Water and Humankind*. New York: Bloomsbury.
- Fales, F. M. 2009–10. "On Assyrian 'Lower-Stratum' Families." *State Archives of Assyria Bulletin* 18: 163–186.
- Galil, G. 2007. *The Lower Stratum Families in the Neo-Assyrian Period*. Leiden/Boston: Brill.
- Gardner, A., ed. 2007. *Agency Uncovered: Archaeological Perspectives on Social Agency, Power and Being Human*. London: University College London Institute of Archaeology Publications.
- Gerbault, P., A. Liebert, Y. Itan, A. Powell, M. Currat, J. Burger, D. M. Swallow, and M. G. Thomas. 2011. "Evolution of Lactase Persistence: An Example of Human Niche Construction." *Philosophical Transactions of the Royal Society B Biological Sciences* 366 (1566): 863–877. doi:10.1098/rstb.2010.0268.
- Gross, R., and V. Winiwarter. 2015. "Commodifying Snow, Taming the Waters: Socio-Ecological Niche Construction in an Alpine Village." *Water History* 7 (4): 489–509. doi:10.1007/s12685-015-0123-0.
- Harrower, M. J. 2009. "Is the Hydraulic Hypothesis Dead Yet? Irrigation and Social Change in Ancient Yemen." *World Archaeology* 41 (1): 58–72. doi:10.1080/00438240802668354.
- Heyvaert, V. M. A., and C. Baeteman. 2008. "A Middle to Late Holocene Avulsion History of the Euphrates River: A Case Study from Tell-ed Der, Iraq, Lower Mesopotamia." *Quaternary Science Reviews* 27: 2401–2410. doi:10.1016/j.quascirev.2008.08.024.
- Heyvaert, V. M. A., J. Walstra, P. Verkinderen, H. Weerts, and B. Ooghe. 2012. "The Role of Human Interference on the Channel Shifting of the River Karkheh in the Lower Khuzestan Plain (Mesopotamia, SW Iran)." *Quaternary International* 251: 53–63. doi:10.1016/j.quaint.2011.07.018.
- Hodder, I. 2012. *Entangled: An Archaeology of the Relationships between Humans and Things*. Chichester: Wiley-Blackwell.
- Hodder, I. 2014. "The Entanglements of Humans and Things: A Long-Term View." *New Literary History* 45 (1): 19–36. doi:10.1353/nlh.2014.0005.
- Hoestaker, R. 2005. "Latour: Semiotics and Science Studies." *Science and Technology Studies* 18 (2): 5–25.
- Jotheri, J., M. B. Allen, and T. J. Wilkinson. 2016. "Holocene Avulsions of the Euphrates River in the Najaf Area of Western Mesopotamia: Impacts on Human Settlement Patterns." *Geoarchaeology: An International Journal* 31 (3): 175–193. doi:10.1002/gea.21548.
- Kaptijn, E. 2015. "Irrigation and Human Niche Construction: An Example of Socio-Spatial Organisation in the Zerqa Triangle, Jordan." *Water History* 7 (4): 441–454. doi:10.1007/s12685-015-0129-7.
- Kendal, J., J. J. Tehrani, and J. Odling-Smee. 2011. "Human Niche Construction in Interdisciplinary Focus." *Philosophical Transactions of the Royal Society B Biological Sciences* 366 (1566): 785–792. doi:10.1098/rstb.2010.0306.
- Latour, B. 1991. "Technology is Society Made Durable." In *A Sociology of Monsters Essays on Power, Technology and Domination*, edited by J. Law, 103–132. London: Routledge.

- Latour, B. 1993. *We Have Never Been Modern*. Cambridge, MA: Harvard University Press.
- Latour, B. 1996. "On Interobjectivity." *Mind, Culture, and Activity* 3 (4): 228–245. doi:10.1207/s15327884mca0304_2.
- Latour, B. 1999. *Pandora's Hope: Essays on the Reality of Science Studies*. Cambridge: Harvard University Press.
- Latour, B. 2000. "When Things Strike Back: A Possible Contribution of 'Science Studies' to the Social Sciences." *British Journal of Sociology* 51 (1): 107–123. doi:10.1080/000713100358453.
- Latour, B. 2002. *War of the Worlds, What about Peace?* Chicago: Prickly Paradigm Press.
- Latour, B. 2007. "Can We Get Our Materialism Back, Please?" *Isis* 98: 138–142.
- Latour, B. 2013. *An Inquiry into Modes of Existence: An Anthropology of the Moderns*. Cambridge, MA: Harvard University Press.
- Linton, J. 2010. *What Is Water? The History of a Modern Abstraction*. Vancouver: UBC Press.
- Marcus, M. I., 1995. "Geography as Visual Ideology. Landscape, Knowledge, and Power in Neo-Assyrian Art." In *Neo-Assyrian Geography QGS5*, edited by M. Liverani, 192–202. Rome: Universita di Roma.
- McAnany, P. A., and N. Yoffee, eds. 2010. *Questioning Collapse: Human Resilience, Ecological Vulnerability, and the Aftermath of Empire*. Cambridge: Cambridge University Press.
- Melosi, M. 2011. *Precious Commodity: Providing Water for America's Cities*. Pittsburgh, PA: University of Pittsburgh Press.
- Mithen, S. 2012. *Thirst: Water and Power in the Ancient World*. London: Weidenfeld & Nicolson.
- Mithen, S., and E. Black, eds. 2011. *Water, Life and Civilization: Climate, Environment and Society in the Jordan Valley*. Cambridge: Cambridge University Press.
- Morris, I., and W. Scheidel, eds. 2010. *The Dynamics of Ancient Empires: State Power from Assyria to Byzantium*. Oxford: Oxford University Press.
- Murphy, J. T. 2012. "Exploring Complexity with the Hohokam Water Management Simulation: A Middle Way for Archaeological Modeling." *Ecological Modelling* 241: 15–29. doi:10.1016/j.ecolmodel.2011.12.026.
- Nelson, M. C., K. Kintigh, D. R. Abbott, and J. M. Anderies. 2010. "The Cross-Scale Interplay between Social and Biophysical Context and the Vulnerability of Irrigation-Dependent Societies: Archaeology's Long-Term Perspective." *Ecology and Society* 15 (3): 31.
- O'Brien, M. J., and K. N. Laland. 2012. "Genes, Culture, and Agriculture: An Example of Human Niche Construction." *Current Anthropology* 53 (4): 434–470. doi:10.1086/666585.
- Odling-Smee, F. J., K. N. Laland, and M. W. Feldman. 2003. *Niche Construction: The Neglected Process in Evolution*. Princeton, NJ: Princeton University Press.
- Ostrom, E. 2012. "Polycentric Systems: Multilevel Governance Involving a Diversity of Organizations." In *Global Environmental Commons: Analytical and Political Challenges in Building Governance Mechanisms*, edited by E. Brousseau, T. Dedeurwaerdere, P. A. Jouvett, and M. Willinger, 105–125. Oxford: Oxford University Press.
- Pollock, S. 1999. *Ancient Mesopotamia*. Cambridge: Cambridge University Press.
- Radner, K. 2000. "How Did the Neo-Assyrian King Perceive His Land and Its Resources?" In *Rainfall and Agriculture in Northern Mesopotamia*, edited by R. M. Jas, 233–246. Istanbul: Nederlands Historisch-Archaeologisch Instituut.
- Rost, S. 2015. "Watercourse Management and Political Centralization in Third-Millennium B.C. Southern Mesopotamia: A Case Study of the Umma Province of the Ur III Period (2112-2004 B.C.)." PhD thesis, Stony Brook University, New York.
- Rost, S., and A. Hamdani. 2011. "Traditional Dam Construction in Modern Iraq: A Possible Analogy for Ancient Mesopotamian Irrigation Practices." *Iraq* 73: 201–220. doi:10.1017/S0021088900000164.
- Rowley-Conwy, P., and R. Layton. 2011. "Foraging and Farming as Niche Construction: Stable and Unstable Adaptations." *Philosophical Transactions of the Royal Society B Biological Sciences* 366 (1566): 849–862. doi:10.1098/rstb.2010.0307.
- Russell, E. 2011. *Evolutionary History: Uniting History and Biology to Understand Life on Earth*. Cambridge: Cambridge University Press.
- Scarborough, V. L. 2003. *The Flow of Power: Ancient Water Systems and Landscape*. Santa Fe, NM: SAR Press.
- Scarborough, V. L., and L. Lucero. 2011. "The Non-Hierarchical Development of Complexity in the Semitropics: Water and Cooperation." *Water History* 2 (2): 185–205. doi:10.1007/s12685-010-0026-z.
- Schouten, P. 2013. "The Materiality of State Failure: Social Contract Theory, Infrastructure and Governmental Power in Congo." *Millennium - Journal of International Studies* 41 (3): 553–574. doi:10.1177/0305829813484818.

- Schwartz, G. M., and J. J. Nichols. 2006. *After Collapse: The Regeneration of Complex Societies*. Tucson, AZ: Tucson University Press.
- Scott-Phillips, T. C., K. N. Laland, D. M. Shuker, T. E. Dickins, and S. A. West. 2014. "The Niche Construction Perspective: A Critical Appraisal." *Evolution* 68 (5): 1231–1243. doi:10.1111/evo.12332.
- Smith, B. D. 2011. "General Patterns of Niche Construction and the Management of 'Wild' Plant and Animal Resources by Small-Scale Pre-Industrial Societies." *Philosophical Transactions of the Royal Society B Biological Sciences* 366 (1566): 836–848. doi:10.1098/rstb.2010.0253.
- Smith, M. L. 2016. "Urban Infrastructure as Materialized Consensus." *World Archaeology* 48 (1): 164–178. doi:10.1080/00438243.2015.1124804.
- Solomon, S. 2010. *Water: The Epic Struggle for Wealth, Power, and Civilization*. New York: Harper.
- Stein, G. J., and R. Oezbal. 2007. "A Tale of Two Oikumenai: Variation in the Expansionary Dynamics of 'Ubaid and Uruk Mesopotamia.'" In *Settlement and Society: Essays Dedicated to Robert McCormick Adams*, edited by E. Stone, 329–342. Los Angeles, CA: Cotsen Institute of Archaeology/Chicago: The Oriental Institute.
- Strang, V. 2014. "Fluid Consistencies: Material Relationality in Human Engagements with Water." *Archaeological Dialogues* 12 (1): 133–150. doi:10.1017/S1380203814000130.
- Strum, S. S., and B. Latour. 1987. "Redefining the Social Link: From Baboons to Humans." *Social Science Information* 26 (4): 783–802. doi:10.1177/053901887026004004.
- Ur, J. A. 2005. "Sennacherib's Northern Assyrian Canals: New Insights from Satellite Imaginary and Aerial Photography." *Iraq* 67: 317–345. doi:10.1017/S0021088900000425.
- Ur, J. A. 2010. "Cycles of Civilization in Northern Mesopotamia, 4400-2000 BC." *Journal of Archaeological Research* 18 (4): 387–431. doi:10.1007/s10814-010-9041-y.
- Ur, J. A., L. De Jong, J. Giraud, J. F. Osborne, and J. MacGinnis. 2013. "Ancient Cities and Landscapes in the Kurdistan Region of Iraq: The Erbil Plain Archaeological Survey 2012 Season." *Iraq* 75: 89–117. doi:10.1017/S0021088900000425.
- Van de Poel, I., and A. C. Van Gorp. 2006. "The Need for Ethical Reflection in Engineering Design: The Relevance of Type of Design and Design Hierarchy." *Science, Technology, and Human Values* 31 (3): 333–360. doi:10.1177/0162243905285846.
- Van De Poel, I., and P. Verbeek. 2006. "Ethics and Engineering Design." *Science, Technology, and Human Values* 31 (3): 223–236. doi:10.1177/0162243905285838.
- Verbeek, P. 2006. "Materializing Morality: Design Ethics and Technological Mediation." *Science, Technology & Human Values* 31 (3): 361–380. doi:10.1177/0162243905285847.
- Waelbers, K., and P. Dorstewitz. 2014. "Ethics in Actor Networks, or: What Latour Could Learn from Darwin and Dewey." *Science and Engineering Ethics* 20 (1): 23–40. doi:10.1007/s11948-012-9408-1.
- Whittle, A., and A. Spicer. 2008. "Is Actor Network Theory Critique?" *Organization Studies* 29 (4): 611–629. doi:10.1177/0170840607082223.
- Wilkinson, T. J., R. Boucharlat, M. W. Ertsen, G. Gillmore, D. Kennet, P. Magee, K. Rezakhani, and T. De Schacht. 2012. "From Human Niche Construction to Imperial Power: Long-Term Trends in Ancient Iranian Water Systems." *Water History* 4 (2): 155–176. doi:10.1007/s12685-012-0056-9.
- Wilkinson, T. J., M. Gibson, and M. Widell, eds. 2013. *Models of Mesopotamian Landscapes: How Small-Scale Processes Contributed to the Growth of Early Civilizations*. Oxford: Archaeopress.
- Wilkinson, T. J., L. Rayne, and J. Jotheri. 2015. "Hydraulic Landscapes in Mesopotamia: The Role of Human Niche Construction." *Water History* 7 (4): 397–418. doi:10.1007/s12685-015-0127-9.
- Wilkinson, T. J., E. Wilkinson, J. A. Ur, and M. Altaweel. 2005. "Landscape and Settlement in the Neo-Assyrian Empire." *Bulletin of the American Schools of Oriental Research* 340: 23–56.
- Williams-Jones, B., and J. E. Graham. 2003. "Actor-Network Theory: A Tool to Support Ethical Analysis of Commercial Genetic Testing." *New Genetics and Society* 22 (3): 271–296. doi:10.1080/1463677032000147225.
- Winiwarter, V., M. Schmid, and G. Dressel. 2013. "Looking at Half a Millennium of Co-Existence: The Danube in Vienna as a Socio-Natural Site." *Water History* 5 (2): 101–119. doi:10.1007/s12685-013-0079-x.
- Winner, L. 1993. "Upon Opening the Black Box and Finding it Empty: Social Constructivism and the Philosophy of Technology." *Science, Technology, and Human Values* 18 (3): 362–378. doi:10.1177/016224399301800306.
- Wittfogel, K. 1957. *Oriental Despotism: A Comparative Study of Total Power*. New Haven, CT: Yale University Press.